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Total Eclipse of the Moon, 1888, *January* 28.

By the Rev. S. J. Perry, D.Sc., F.R.S.

The long duration of this eclipse, and the pains taken by Professor Döllen in calculating the positions of the stars to be occulted at Stonyhurst during totality, made me give special attention to the preliminary observations for this eclipse. Some of the star places were recalculated by the Rev. W. Crofton, as Professor Struve in his circular to the observatories had requested that this should be done for greater security, and the results proved that the graphical method adopted by Professor Döllen was sufficiently accurate. A careful map was also drawn of all the stars to be occulted, and this was compared with the charts of Chacornac and Argelander in order to identify as many stars as possible beforehand. A 5½-inch achromatic of Alvan Clark, which gives most perfect definition, was set apart for the occultations, and was supplemented by a 4-inch equatorial of Jones. The 8-inch instrument of Simms was reserved for a spectroscopic examination of the light of the eclipsed Moon, and the spectroscope used on this equatorial was so constructed by Hilger that one or two prisms of 30° can be used at will, six sets of prisms of aluminium, quartz, calcite, dense flint, white flint, and crown glass being adapted to the same mounting. A series of observations was made with the different prisms during the week that preceded the eclipse, measurements of the lines in the spectrum of the clouds and also of the lunar crescent were taken, and the spectroscope was found to work very satisfactorily. Two aluminium prisms gave altogether the best results, as the lunar spectrum was strong, and the fine lines distinct throughout. A single prism of aluminium glass, or of white flint, gave equally good definition, though the lines were somewhat clearer in the violet with the aluminium, and in the rest of the spectrum with the flint. The calcite was at least as good as either of the other prisms in the red, and was fair in the violet, but much inferior in the remainder of the spectrum. The dense flint and crown gave the lines less distinctly; but with one, or with two, quartz prisms the details were seen almost as well as with the aluminium. I am dwelling rather longer on these preliminary observations than might perhaps be deemed necessary, but I am doing so advisedly, as the trustworthiness of the results obtained during the eclipse must depend mainly on the fitness of the spectroscope for the object proposed.

Early on the evening of the eclipse the sky was all that could be desired, and the penumbra was very visible on the Moon at $8^h\ 48^m$. A series of readings of the principal lines in the lunar spectrum was then taken, the two aluminium prisms being used, and giving a very extended spectrum. During these measures cirrus clouds were thickening, and a brilliant double halo formed round the Moon two orange rings, of about 12° and 16° in

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diameter, enclosing a space of a greenish-blue tint. At $9^h\ 25^m$ the penumbra at the eastern limb had become very dark, and at $9^h\ 29^m$ the shadow gave the limb the appearance of being flattened, which was probably the effect of the first contact of the umbra. At $10^h\ 5^m$ nearly the whole of the limb of the partially eclipsed Moon, and also great part of the shaded surface, was clearly visible in spite of cirrus clouds. The outline of the umbra was not very regular, a long depression appearing near the centre with a considerable elevation north of the centre, and a less striking one near the south point. At $10^h\ 12^m$ the eclipsed portion of the Moon was becoming more distinct, its colour being a brick red, but almost orange in the brighter parts. Five minutes before totality thin clouds were still around the Moon. The beginning of totality was noted at $10^h\ 30^m\ 21^s\!\cdot\!9$ G.M.T. About five minutes after totality commenced the stars were shining brightly in every direction, and the fainter ones were visible in the telescope, showing that the clouds had entirely disappeared. A curious wedge-shaped and very dark shade was observed on the lunar surface, and its form cannot be accounted for by any of the known features of the Moon.

The eclipsed Moon, which was very distinct, although its general appearance was that of a bright object seen through a fog, was being kept by the driving clock on the slit of the spectroscope, lest any uncertainty as to its exact position might arise—a precaution not always unnecessary in previous eclipses. The viewing telescope of the spectroscope had been most carefully focussed on the green part of the spectrum, with the pointer of the micrometer fixed on the line corresponding to 1474 K. I chose this position because I thought that, if any bright lines from the outer corona were reflected by the lunar surface, this well known coronal line would be the most conspicuous. Nothing was altered, no screw touched, and I felt sure that the two aluminium prisms were under the best conditions for showing the true spectrum of the eclipsed Moon. I scarcely expected to see so much light through the spectroscope with so narrow a slit, but I looked in vain for any sign of bright or dark lines, and my assistant, Mr. W. McKeon, whose eye is exceedingly well trained, was equally unsuccessful in detecting lines. The spectrum, extending from the red to somewhat beyond F, was of a rather indistinct yellowish green throughout. A wider slit increased the amount of light, and showed the red end of the spectrum fairly well, but the violet was completely cut off, as well as most of the blue. No appearance of lines, or even of increased intensity of light, at any point of the spectrum could be noted.

At $10^h\ 40^m\ 17^s$ the west limb to a considerable width was much brighter than the rest of the surface, and interfered very much with the faint stars whose occultations were being observed through the $5\frac{1}{2}$ and 4-inch achromatics.

The triangular, or wedge-shaped, patch of shadow had now become much darker than the remainder of the surface; but at $10^h\ 54^m\ 30^s$ this dark patch was already more diffused.

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One prism of aluminium glass, and then one of quartz, and lastly one of white flint, were now tried in the spectroscope, but with no other result than that obtained with the two prisms of aluminium; although the quartz gave a larger quantity of light, especially at the red end of the spectrum, whilst with the flint prism the red was scarcely visible. As we had not the advantage of focussing on the bright Moon before each of these changes, the observation with the two prisms of aluminium can alone be considered perfectly satisfactory, although the observations with the single prisms afford some confirmation of the previous result. The spectrum of the eclipsed Moon was, I think, quite bright enough to have shown dark lines had the ordinary solar lines been present; and I hardly imagine that the diminution of light, in passing from the spectrum of the bright to that of the eclipsed Moon, was sufficient to account for the total absence of so much of the blue end of the spectrum. I hope on July 22 of this year again to examine the spectrum of the eclipsed Moon with the same instrument, but substituting quartz lenses, in place of ordinary achromatics, for the collimator and viewing telescope; and then with quartz prisms the violet end, if not greatly absorbed, will scarcely escape detection.

At 11^{h} 10^{m} the surface of the Moon was throughout of a more uniform tint, the seas, however, being of a somewhat darker red than the other portions; the only exceptional feature was a not very conspicuous brightening of the southern limb. The irregular dark patch mentioned above had entirely vanished. At 11^{h} 27^{m} the illumination of the limb was passing round to the eastern side. At midnight the Moon's edge was rapidly brightening, and at 12^{h} 7^{m} 13^{s} the end of totality was noted. Two small bright projections, about 8° apart on the limb, were very striking in the 4-inch finder; they were near the point of reappearance.

The following is a list of the observed occultations, the stars being numbered according to the printed list sent by Professor O. Struve to the observatories of Europe.

Star.	Greenwich Mean Time.		Diam. of O.G.	Power.	Observer.	Remarks.
	Disappearance.	Reappearance.				
	h m s	h m s				
157	10 35 8·1	—	5½	46	W. J. C.	Passing clouds.
164	10 37 6·5	11 50 44·1	4	44	A. C.	
,,	10 37 6·7	11 50 44·1	5½	46	W. J. C.	
136	—	10 46 9·7	,,	,,	,,	
180	10 50 51·3	—	,,	,,	,,	
,,	—	11 59 2·6	,,	,,	W. C.	
126	—	11 1 33·8	,,	,,	W. J. C.	
209	11 25 48·4	—	,,	,,	W. C.	Very faint.
201	11 29 16·1	12 10 14·4	4	44	A. C.	
,,	11 29 16·4	12 10 14·2	5½	46	W. C.	
166	—	11 47 19·1	,,	,,	,,	
165	—	11 51 29·8	,,	,,	,,	
236	11 55 40·4	—	8	43·5	S. J. P.	Last seen.

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The initials W. J. C., A. C., W. C., and S. J. P., are those of the observers William Crofton, Aloysius Cortie, William Carlisle, and Stephen Joseph Perry.

Stonyhurst Observatory:
1888, *February* 16.

Occultations observed at Harrow during the Total Eclipse of the Moon, 1888, *January* 28. By G. L. Tupman.

Every precaution was taken to ensure success on this occasion, but fleecy clouds and haze and the unexpected brightness of the Moon rendered the smaller stars quite invisible.

General Tennant very kindly came over and observed with the 18-inch mirror, using the chronograph to register the times. He says:—

"Very soon after totality commenced the sky near the Moon was clouded, and from that time, although the Moon's limb was generally visible, stars were rarely so. From what was seen, it was evident that the Moon was very bright and white in colour, even on the limb near the centre of the shadow (the other limb was much brighter), and that the smaller stars could not have been seen in contact with the limb. Indeed, at the disappearance of No. 166 and No. 164 each was thought to be gone some 3^{s} before the times noted, but a re-examination showed that they were still on the limb though hardly distinguishable."

I looked at the Moon for a minute or two, with the large reflector, half an hour after the commencement of totality. Not a star was to be seen near it. I do not agree with General Tennant that the Moon was white; to me it was very red, although less red in the telescope than with the unaided eye.

The following are the times as read from the chronograph fillet; they should be diminished $0^{s}{\cdot}3$ or $0^{s}{\cdot}4$:—

Star.	Clock.				Local Sidereal Time.			Greenwich Mean Time.		
		h	m	s	h	m	s	h	m	s
157	Im.	7	3	17·2	7	2	26·65	10	33	15·9
166	Im.	7	8	18·5	7	7	27·95	10	38	16·4
164	Im.	7	9	25·2	7	8	34·65	10	39	22·9
164	Em.	8	24	0·0	8	23	9·45	11	53	45·5
180	Em.	8	34	23·3	8	33	32·75	12	3	7·1*

* This was seen as a bright speck on the limb at this moment; but the limb was only seen clearly for a few seconds, and before the observation could be verified it was dulled by the mist.—J. F. T.